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PATENT APPLICATION
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METHOD FOR MANAGING MANUFACTURING DATA

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1 METHOD FOR MANAGING MANUFACTURING DATA

2 Field of the Invention

3 The present invention relates to methods for managing manufacturing
4 systems. In particular, the present invention relates to methods for managing
5 information flow along a manufacturing supply chain regarding product
6 specifications.

7 Background of the Invention

8 In order to provide an acceptable level of quality for commercial
9 products, a product tracking data history for the product needs to be built
10 during the manufacture process. Generally, this data history provides a list of
11 which components were installed in the product, when they were installed, and
12 how they were installed. The product tracking data history may further include

1 a history of performance tests done on the product as well as any product
2 defects that have been discovered.

3 Current manufacturing practices for large companies often involve the
4 manufacture of a product by a manufacturing group that is far removed from
5 the product designers. A plurality of component parts may be obtained from
6 outside vendors that are then assembled to build the product. Under these
7 circumstances it is difficult to build an accurate product tracking data history
8 due to the many layers of organizational separation that exist within the
9 company between the product designer, or "owner", and the ultimate
10 assembler.

11 This problem is even more acute in so called "contract manufacturing"
12 situations, where a product is manufactured for a product owner by an external
13 contractor. These situations have become popular in industry as they allow the
14 product owner to focus on product research, development, and marketing. As
15 an example, a computer peripheral manufacturer may research and design
16 products, and then contract out the manufacture of those products.

17 In both cases of internal manufacturing and contract manufacturing, the
18 process of manufacturing a product through purchase of commodity component
19 parts which are then assembled together may generally be referred to as a
20 "supply chain". In essence, each of the various component vendors and the
21 assemblers, whether they are internal groups or external contractors, are a link
22 in the supply chain. The final assembly link of the chain is critical, as it is here
23 that the component parts are gathered together and the product is put in a final
24 form. Because the product owner is removed from this final assembly link, the
25 task of building an accurate product tracking data history is difficult.

26 At the final assembly link, the gathering of component parts and product
27 assembly may occur under a "manufacturing execution system" ("MES"). The
28 MES system generally coordinates product assembly by listing component
29 parts required, times when they are required, places for the parts to be
30 delivered, and specifications for assembling the product. The removed product
31 owner or designer often depends completely on the contract assembler's MES

1 to implement the owner's specifications, and to provide data for building a
2 product tracking data history.

3 Relying on the assembly link MES in building a product tracking data
4 history, however, has proven less than satisfactory, particularly for contract
5 manufacturing situations. Generally, relying on the assembly link MES
6 requires the accurate transfer of large amounts of data and know-how between
7 the product owner and the assembly MES. These tasks add effort and cost to
8 the product manufacture. Additionally, this is particularly difficult when the
9 MES is within an external contractor.

10 Under these circumstances, the product owner must rely on the
11 contractors to accurately transfer data. Errors may be introduced when, for
12 example, a contractor reports that a certain product was built using a given
13 specification or had particular performance testing results when in fact this data
14 is in error. The possibility for these errors always exists when systems rely on
15 external organizations to install methods and systems, to gather data, and to
16 interpret and report data.

17 Partly in response to difficulties associated with relying on external
18 organizations for obtaining and reporting tracking data, methods for building
19 product data tracking histories have been proposed in which the product owner
20 provides automated testing and documenting tools, often in the case of
21 computer based tools. Often these tools are installed onto the contractors
22 computer based MES system. In addition to providing assembly specifications,
23 these tools may be able to be run by the contractor to document product
24 components and to determine product performance. In theory they may lower
25 the burden placed on the contractors, and in turn may improve accuracy of data
26 transfer to the product owner.

27 In practice, however, such systems have proven less than satisfactory.
28 These computer based tools may require a considerable degree of technical
29 knowledge to install and operate, which translates to costly information
30 technology support for the contractor. Additionally, assembly contractors and
31 groups are typically staffed with relatively low skill operators who are not well

1 suited for operating many of the computer based product history tools. After
2 turning the tool over to the contractor, the product owner must rely on the
3 contractor to insure that the tool is installed and being used correctly. Further,
4 the tools have done little to alleviate the difficulties associated with transferring
5 large amounts of data between owner and contractor. Finally, use of such
6 computer based tools also introduces a new set of administrative problems in
7 that the tools must be continuously updated and tracked to insure that each
8 supply chain contractor is running the latest version of a particular tool.

9 Additional problems exist in building product data tracking histories
10 related to detecting and resolving product defects. Even if the reliability of the
11 individual components has been assured, they must still be properly installed to
12 interface with one another. This is particularly true of technically sophisticated
13 products such as computer peripherals. To insure proper interface, product
14 owners may require performance testing at the assembly stage. The product
15 owner provides specific testing protocols, which may change during the
16 product lifespan as components change.

17 Often the test protocols are provided in the form of computer based
18 tools, which the contractor must install and maintain. These must be regularly
19 updated and documented as the protocols change. This again introduces
20 technical support and administrative problems for the contractor and the
21 product owner and adds cost to the manufacturing process. Additionally, in
22 contract manufacturing situations, the product owner must again rely on an
23 external organization to install, maintain, and accurately document testing
24 protocols and results.

25 When performance testing detects a defect, the product may be sent to
26 yet another contractor for defect resolution. This second contractor will need
27 access to the product tracking data history to resolve the defect. The second
28 contractor also needs to know what sorts of performance tests were run, and
29 what defects those tests discovered. Providing all of this data to the second
30 contractor requires time and effort from the product owner, thereby adding cost
31 and delay to the manufacture process.

1 There are hence heretofore unresolved needs for methods for building
2 product tracking data histories as a product is manufactured.

3 Summary of the Invention

4 The present invention generally comprises an improved method for
5 building a product tracking data history for a product of the type that has a
6 processing means, with the method utilizing a communications network with a
7 central computer device attached thereto. The method generally comprises the
8 steps of installing a remotely operable diagnostic tool on the product, assigning
9 a unique product identity code to the product, and connecting the product to the
10 communications network during its manufacture so that the diagnostic tool may
11 be remotely operated over the communications network to provide product
12 specification data. A product tracking data history can then be built using the
13 reported product specification data.

14 Preferably, the diagnostic tool comprises at least computer executable
15 instructions recorded on a computer accessible medium, such as an integrated
16 circuit chip. The recorded instructions are preferably capable of determining
17 an inventory of components installed on the product, and of providing the
18 unique product identity code.

19 In an additional embodiment of the improved method of the invention,
20 operator computer devices that are used for at least a portion of the product
21 manufacture are connected to the communications network. This embodiment
22 further comprises steps of placing product assembly specifications on a central
23 data repository connected to the central computer, which are transmitted from
24 the central data repository to the operator computer devices for use during the
25 product manufacture. The diagnostic tool reports back to the central computer
26 device a unique identity code corresponding to the assembly specifications
27 being used to assemble the product. This data is then included in the product
28 tracking data history, so that an accurate and automatically reported record of
29 what specifications were used to assemble the product is created.

1 In still an additional embodiment of the invention, product performance
2 test protocols are placed on the central data repository. When the product is
3 connected to the communications network during its manufacture, the
4 diagnostic tool may be remotely operated over the network from the central
5 computer to execute the test protocols and to report back to the central data
6 repository an identity code for the protocol test performed as well as test
7 results. This data is then included in the product tracking data history. Upon a
8 FAIL result for any performance test, a product defect tracking history file may
9 be created at the central data repository.

10 This embodiment of the improved method of the invention thereby
11 results in accurate product testing without a requirement for expensive operator
12 training or action. Additionally, accurate and automatically reported history of
13 tests performed and test results are thereby reported. Finally, upon the
14 occurrence of a test FAIL result, a centralized product defect history is started
15 that may be conveniently accessed during the defect resolution process over the
16 communications network by additional entities along the supply chain.

17 In a most preferred embodiment of the method of the invention, the
18 product is being manufactured by at least an external contractor for the product
19 owner. In this embodiment of the invention, the central computer device is
20 under the control of the product owner, and each of the external contractors is
21 connected to the communications network for interface with the central
22 computer device. It will be appreciated that practice of this embodiment of the
23 invention allows a product owner to keep accurate and tight control over the
24 external manufacture of the product, as well as an accurate history of its
25 manufacture.

26 All of the various embodiments of the method of building a product
27 tracking history briefly described above thereby resolve several of the
28 heretofore unresolved problems in the art. In general, the various embodiments
29 of the methods of the invention advantageously remove layers of required
30 interface and action in the product tracking data transfer process between the
31 product owner and the product manufacturers. Depositing product assembly

1 specifications and product testing protocols at a central data repository for
2 remote access by contractors solves many problems associated with the transfer
3 of this data. Installing a self diagnostic tool that is operated remotely over the
4 communications network solves many additional problems related to installing
5 and supporting systems at the contractor site for product testing. The various
6 embodiments of the method of the invention thereby offer a greatly improved
7 method for building a product data tracking history.

8 The above brief description sets forth rather broadly the more important
9 features of the present disclosure so that the detailed description that follows
10 may be better understood, and so that the present contributions to the art may
11 be better appreciated. There are, of course, additional features of the disclosure
12 that will be described hereinafter which will further describe the subject matter
13 of the invention. In this respect, before explaining an embodiment of the
14 disclosure in detail, it is to be understood that the disclosure is not limited in its
15 application to the details of the construction and the arrangements set forth in
16 the following description or illustrated in the drawings. The present invention
17 is capable of other embodiments and of being practiced and carried out in
18 various ways, as will be appreciated by those skilled in the art. Also, it is to be
19 understood that the phraseology and terminology employed herein are for
20 description and not limitation.

21 Brief Description of the Drawings

22 FIGURE 1 is a schematic of a product owner and external
23 manufacturing contractors useful in describing practice of an embodiment of
24 the method of the invention.

25 FIGURE 2A-2B is a flowchart illustrating a set of steps of an
26 embodiment of the method of the invention.

27 Detailed Description

28 The schematic of FIG. 1 will be helpful in describing a preferred
29 embodiment of the method of building a product data tracking history of the

1 invention. As discussed above, it has been discovered that the method of the
2 present invention is of particular utility for the manufacture of technically
3 sophisticated products, such as computer peripherals. Accordingly, a preferred
4 embodiment will be described in reference to the hypothetical production of a
5 computer printer by Acme Co. 2 as shown in FIG. 1. The schematic of FIG. 1
6 illustrates a contract manufacturing situation, where Acme 2 has contracted out
7 the manufacture of a printer 4 to Contractor Alpha 6. It may be assumed that a
8 plurality of component parts have been obtained and shipped to Alpha 6, where
9 they will be assembled to create the final printer 4. Thus, Alpha 6 represents
10 the final assembly "link" in the supply chain for manufacturing the printer 4.
11 Contractor Beta 8 has also been contracted with for partial product
12 manufacture; in particular Beta 8 will perform defect resolution tasks should a
13 product defect be detected.

14 This preferred embodiment of the method of the invention will use a
15 communications network 10. "Communications network" as used herein is
16 intended to refer to a means for achieving communication between entities, and
17 may include by way of example and not limitation, wide area data networks,
18 local area data networks, virtual private data networks, a telephone network,
19 wireless networks, and the World Wide Web or Internet. Because of its
20 relative low cost and relative wide availability, the Internet is a preferred
21 communications network for the practice of this embodiment of the invention
22 method.

23 A central computer device 12 is under Acme 2 control. As used herein,
24 the term "under control" is intended to refer to a general condition of being
25 operably accessible and securable. That is, a computer device may be
26 considered to be "under the control" of an entity if that entity may generally
27 direct its operation and may exclude others from using the computer device.
28 Thus, for instance, a computer device would be under the control of Acme it is
29 in Acme's facility and run by Acme's employees, if it is at a computer operator
30 facility that is contractually obligated to Acme to operate the computer as
31 Acme may direct, or the like.

1 Computer device 12 may comprise, by way of example and not
2 limitation, a processor based server device such as a personal computer,
3 workstation, or mainframe computer. The term "computer" and "computer
4 device" are thus intended herein to be read in their broadest light, and generally
5 are intended to refer to any machine capable of processing instructions.
6 Preferably, a central data repository 14 is further provided and is connected to
7 the central computer device 12. The data repository 14 may comprise a storage
8 medium located in the central computer device 12, or may comprise a remote
9 storage medium such as an external disk drive, or even a storage medium such
10 as a disk drive residing in a second computer device. The central computer
11 device 12 is connected to the network 10.

12 As used herein, to "connect" an entity to the communications network is
13 intended to only refer to operably enabling communications between the
14 network and the entity. No particular physical steps are required. In the
15 schematic of FIG. 1, data connections are illustrated with lines, which as will
16 be appreciated may represent phone lines, copper or fiber data lines, wireless
17 connections, or other means of data transfer.

18 The method of the invention may further comprise connecting
19 contractors Alpha 6 and Beta 8 to the network 10. Preferably, at least one
20 operator computer device 16 is provided at each contractor Alpha 6 and Beta 8,
21 with the operator computer device 16 of each respective contractor being
22 connected to the network 10. The operator computer device 16 is a processor
23 based machine, and may comprise by way of example a server device, a
24 personal computer, a workstation, or other processor based machine. The
25 operator device 16 is used to facilitate at least a portion of the manufacture of
26 printer 4. Operator computer device 16 will facilitate connection to the printer
27 4 when it is present at the particular contractor. In this manner, the printer 4
28 may be connected to data the network 10 for communication with Acme 2. At
29 least one monitor 18 is preferably also provided at each of the contractors
30 Alpha 6 and Beta 8 connected to the operator computer device 16.

1 It will be appreciated that a plurality of operator computer devices 16
2 and monitors 18 may be comprised at Alpha 6 and Beta 8. These computer
3 devices 16 and monitors 18 may be networked together in a LAN or WAN
4 arrangement within one or more of the contractors. Further, it will be
5 appreciated that the preferred output device comprising monitor 18 may further
6 comprise means for inputting data, such as virtual screen buttons or the like
7 that may be used by an operator to input data.

8 Each of the plurality of contractors Alpha 6 and Beta 8 can
9 communicate with the central computer device 12 and the data repository 14
10 over the network 10. Likewise, the printer 4 may communicate with the central
11 computer device 12 and the data repository 14 over the network 10 when
12 connected to the operator computer device 16 at any of the contractors 6 or 8.

13 The method of the invention further comprises the step of assigning a
14 unique product identity code to the printer 4. For purposes of example, the
15 printer 4 is assigned a code of "AZ467". The code is preferably assigned to the
16 printer 4 by physically recording the product identity code on the printer 4 in a
17 computer readable format. It is noted that FIG. 1 as illustrated shows a printer
18 4 at each of contractor Alpha 6 and Beta 8. It will be appreciated that this is for
19 purposes of illustration only, since in practice there is only one unique printer 4
20 with identity code AZ467.

21 Each of Acme 2, Alpha 6, and Beta 8 have a firewall 21 placed between
22 them and the network 10. It will be appreciated that such a configuration is
23 advantageous for security reasons, particularly when the communications
24 network 10 is widely available to other users, as of course is the case when the
25 network 10 comprises the internet. As will be appreciated by those
26 knowledgeable in the art, the firewall 21 may take the form of various devices
27 or applications, and as used herein is intended to refer broadly to a security
28 application designed to selectively allow communication therethrough.

29 The preferred embodiment of the method of the invention further
30 comprises the step of assigning a unique contractor code to each of the plurality
31 of contractors. For purposes of example herein, the contractors 6 and 8 of FIG.

1 have been assigned codes of “Alpha”, and “Beta”, respectively. It will be appreciated that a wide variety of unique coding schemes for both contractors and products can of course be comprised, the method of the invention only requires that the codes be unique in that each contractor and each individual product can be identified.

An additional step of the method of the invention is to install a diagnostic tool on the printer 4. “Diagnostic tool” as used herein is intended to refer to a tool that may be operated to provide data regarding the product condition. Preferably, the diagnostic tool comprises at least a set of recorded processor executable instructions. A preferred example of a diagnostic tool comprises a chip with computer executable instructions stored in flash memory thereon for performing desired steps when queued. Other examples may comprise computer executable instructions recorded on other mediums. Thus, a diagnostic tool may comprise recorded instructions on a magnetic or optical storage medium. For purposes of illustration only, a diagnostic tool has been illustrated as a black box 20 shown in the printer 4, which may be considered to be a chip. Preferably, the diagnostic tool 20 has recorded computer executable instructions thereon for providing the printer’s unique identity code, at least a partial inventory of components installed on the printer 4, and for performing certain performance tests.

In an additional step of the preferred embodiment of the method of the invention, at least a set of product assembly specifications is placed in the central data repository 14. The term “a set of product assembly specifications” as used herein is intended to refer to specifications regarding the construction, design, or assembly of a product. For purposes of illustration, sets of assembly specifications have been illustrated in FIG. 1 by file 22 in the central repository 14. Each component to be installed may require an individual set of assembly specifications 22. Alternatively, a single set of assembly specifications 22 may provide instruction for multiple components to be installed by a single or several contractors. For purposes of example and convenience, it is put forth that a plurality of individual sets of assembly specifications as will be required

1 for assembly of the printer 4 are present in the single file 22 of FIG. 1. Each
2 individual set of assembly specifications are additionally provided with a
3 unique identity code.

4 Under circumstances of contract manufacturing, product performance
5 tests will often be required of the contract assembler. In the case of Alpha's 6
6 assembly of the printer 4, for example, Acme 2 may require Alpha to conduct a
7 performance test after each component has been installed to insure that it is
8 properly installed and interfacing with other components properly.
9 Accordingly, a further step of the preferred embodiment of the method of the
10 invention is to place a set of performance test protocols on the central data
11 repository 14. "Product performance test protocols", as used herein, are
12 intended to refer broadly to instructions for testing the performance of a
13 product component. Preferably, the instructions are computer readable and are
14 executable by diagnostic tool 20.

15 For purposes of illustration, a product performance test protocol has
16 been illustrated as the file 24 in the data repository 14 of FIG. 1. The
17 performance test protocol file 24 may be considered to contain a plurality of
18 individual recorded performance test protocols, each of which is assigned a
19 unique identity code in an additional step of the preferred embodiment of the
20 method of the invention.

21 Through still additional steps of the method of the invention, diagnostic
22 tool 20 will be remotely operated from the central computer device 12 to
23 provide various product tracking data during the manufacture of the product 4
24 when connected to the network 10. The diagnostic tool 20 will also be
25 remotely operated to execute performance tests, and to report results over the
26 network 10. These capabilities represent important advantages of the method
27 of the invention over methods of the prior art. Generally, such a configuration
28 advantageously removes dependence on the supply chain contractors Alpha 6
29 and Beta 8 to accurately transfer product-tracking data to Acme 2.
30 Additionally, the burden of installing, operating, and maintaining systems to
31 obtain this data is removed from contractors Alpha 6 and Beta 8.

1 In the preferred embodiment of the method of the invention, when the
2 printer 4 is connected to the communications network 10 while at Alpha 6 or
3 Beta 8, three general types of data exchanges occur over the network 10 with
4 Acme 2: 1) the sets of assembly specifications 22 are transmitted from the
5 central repository 14 for the manufacture of the printer 4; 2) certain printer 4
6 diagnostic data is obtained through remote operation of the tool 20 and
7 transferred to the data repository 14; and 3) the performance test protocols 24
8 are transmitted from the repository 14 for execution by the diagnostic tool 20
9 with test results then transferred directly back from the diagnostic tool 20 to the
10 repository 14. A comprehensive product data tracking history can then be
11 assembled by the central computer device 12 using these three general types of
12 data.

13 To further illustrate the preferred embodiment of the method of the
14 invention, a product-tracking data history will be assembled for the printer 4 of
15 FIG. 1 with unique product identity code AZ467. The sample product tracking
16 data history that results from practice of this embodiment of the method of the
17 invention is illustrated in Table 1. It will be appreciated that this product
18 tracking data history is presented for illustration only, and is not intended to
19 express any limitations regarding product data tracking histories built through
20 the method of the invention as claimed, which may contain more or less data
21 than that illustrated and which may be in different formats. The steps of the
22 method taken to build this history will be discussed in detail below.

Product Tracking Data History for Product Code: AZ467						
Contractor:	Dates Printer at Contractor:	Components:			Product Performance Tests:	
		Components installed at Contractor:	Date Installed:	Assembly Specifications Used at Contractor to install Component:	Performance Test Protocol with Results for Tests at Contractor:	Date Test Run at Contractor:
Alpha	9/3/00 – 10/11/00	Board 11	9/4	Board Rev. 1	Board Test Rev. 2: PASS	9/4
		Motor 14C	9/4	Motor Rev. 1	Motor Test Rev. 1: PASS	9/4
		Bus	9/6	Bus Rev. 2	Bus Test Rev. 1: PASS	9/6
		LCD Screen JX3	9/20	Screen Rev. 1(b)	Screen Test Rev. 1(b): PASS	9/21
		Printer Drive Head Z	10/3	PH Rev. 3	PH Rev. 2: PASS	10/4
Beta	10/19/00 – 10/26/00	Disk Drive SD3	10/5	Disk Drive Rev. 1	Disk Drive Rev. 2: FAIL	10/5
		Disk Drive SD3	10/25	Disk Drive Rev. 1	Disk Drive Rev. 2: PASS	10/25
		Disk Drive SD3	10/25	Disk Drive Rev. 1	Board Test Rev. 2: PASS	10/25

Table 1: Example Product Tracking History

1 In order to better illustrate the preferred embodiment of the method of
2 the invention, the steps of the method will be discussed in detail from the point
3 at which the printer 4 with diagnostic tool 20 installed thereon is connected to
4 the operator computer device 16 at Alpha 2 of FIG. 1. It will be appreciated
5 that by the time this occurs, a number of component parts have been obtained,
6 gathered together, and delivered to an operator for assembly.

7 Reference is now drawn simultaneously to FIG. 1 as well as FIGS. 2A-
8 2B, which are a flow chart illustrating the preferred set of method steps that
9 occur once the operator at Alpha 2 has been delivered all component parts for
10 the printer 4 and is ready to begin assembly. At this point (100), a set of
11 product assembly specifications 22 are transmitted over the network 10 for
12 output on the Alpha operator output device 18. Preferably, as illustrated, the
13 output device 18 comprises a monitor on which the operator will view
14 assembly specifications on a step by step basis. Other output devices may
15 comprise printers or other devices.

16 The Alpha operator then assembles the printer 4 following the assembly
17 specifications 22 (102). Assembly specifications may comprise descriptions of
18 parts to be installed, as well as instructions for installation. They may be
19 presented in a step-by-step manner, with the operator required to interact with
20 the output device 18, such as, by way of example, clicking a mouse button or
21 striking a "virtual" button on the output device 18 after each step to begin the
22 next step. Additionally, assembly may occur on an assembly line between a
23 number of different operators. In this case the method of the invention will
24 comprise providing a plurality of the output devices 18, with one for each
25 operator station.

26 Importantly, through the method of the invention the actual file 22
27 containing these assembly specifications remains under Acme's control on the
28 central data repository 14. This allows Acme to retain tight and accurate
29 control over the assembly specifications actually being used during product
30 manufacture by the various contractors. Any changes to assembly
31 specifications that need to be made can be easily accomplished without

1 requiring any actions on the part of the contractors. The method of the
2 invention thereby completely removes any uncertainty as to which version of
3 assembly specifications are being used by the contractor. Further, burdens on
4 contractors such as Alpha associated with installing, maintaining, and updating
5 assembly specifications are eliminated.

6 The preferred embodiment of the invention further comprises storing
7 previous versions of assembly specifications in the central data repository 14 as
8 newer versions are installed. This advantageously creates an archive for future
9 reference that can be widely accessed over the network 10.

10 As indicated by the sample product data tracking history of Table 1, the
11 printer 4 is assembled using individual assembly specification sets for a board,
12 a motor, a bus, an LCD screen, a printer drive head, and a disk drive. Again
13 referring to FIGS. 1 and 2, the operator prompts the output device 18 that
14 assembly of the printer 4 is completed (104). The operator is then prompted to
15 connect product 4 to the operator computer device 16 (106). Connection may
16 occur, by way of example, by the operator connecting a pin connector on a
17 cable to a serial port connection, or by initiating a wireless connection with the
18 product 4. Other modes of connection are of course within the scope of the
19 invention as will be appreciated by those knowledgeable in the art.

20 The diagnostic tool 20 is then remotely operated over the network 10
21 from the central computer device 12 (108) to provide product specification data
22 (110). As indicated, this specification data preferably comprises at least the
23 product unique identity code AZ467, an inventory of installed components, and
24 a list of assembly specification set identity codes used to install the various
25 components in the product. Table 1 indicates that installed components are
26 identified by a model number. It is within the scope of the invention to also
27 identify installed components by serial number or other identifying data.

28 It is also noted that not all components need be listed. Indeed, the
29 preferred embodiment of the method of the invention will provide an inventory
30 only of relatively "high touch" electronic components that are important to the
31 product operation. Things such as housings and simple mechanical parts

1 without electronic interface may not be practical to inventory or test with the
2 diagnostic tool 20.

3 It is further noted that the scope of the invention as claimed is not
4 limited to this specification data being provided only from the diagnostic tool
5 20, but may for example also be obtained by combining some data provided by
6 the tool 20 with data obtained by the central computer device 12. For instance,
7 after learning the identity code of product 4 and inventory of installed
8 components from the tool 20, the central computer 12 may query the data
9 repository 14 to obtain identity codes for the current assembly specifications
10 corresponding to the installed components.

11 Product performance testing of product 4 may then be initiated (110).
12 This involves transmission of product performance test protocols in file 24 over
13 the network 10 for execution by diagnostic tool 20. As indicated by the sample
14 product tracking data history of Table 1, performance test protocols may be run
15 on each individual component. Preferably, the performance test protocols
16 when executed by diagnostic tool 20 will at least indicate whether the
17 component being tested is interfacing properly with other components. Test
18 protocols preferably have a PASS/FAIL outcome. In addition to having an
19 individual performance test protocol for each component, performance test
20 protocols may be executed that measure performance of a plurality of
21 components in a single test. A test protocol may even be executed for
22 measuring the overall product performance.

23 The method of the invention thereby achieves several advantageous
24 results in product performance testing over methods of the prior art. Because
25 test protocols are retained under the product owner's control, any uncertainty as
26 to which test protocol is being run has been removed, and any changes that
27 need to be made in terms of installing new revisions of test protocols can be
28 very quickly accomplished. Further, remote operation of the diagnostic tool 20
29 from the central computer device 12 to execute performance test protocols
30 removes the burden of installing, maintaining, and performing tests from
31 contractors such as Alpha.

1 Product performance test protocols may provide an interface screen on
2 the central computer device 12 for an Acme operator to participate in executing
3 the test. As an example, an interface screen may display test results
4 dynamically, with the Acme operator able to remotely direct the diagnostic tool
5 20 to take any of several actions as may be desired depending on the
6 dynamically displayed test results. By way of additional example, execution of
7 test protocols may request other operator interaction. With reference to Table
8 1, the LCD screen installed on the printer 4 is to be performance tested under
9 test protocol Screen Test Rev. 1(b). This test protocol may direct the
10 diagnostic tool 20 to test a connection between the main board and the screen,
11 and then to test the screen operation by displaying certain characters on the
12 screen. The test protocol may further direct that the operator is to interact with
13 the operator output device 18 by clicking a mouse, pressing a virtual screen
14 button, or in some other manner to confirm that the characters are displayed on
15 the screen. Other test protocols by way of example may direct the Alpha
16 operator to turn printer switches on and off or to take other actions on the
17 printer.

18 The central computer 12 directs the diagnostic tool 20 to transmit
19 PASS/FAIL results for performance testing to the central computer device 12,
20 along with the test identity code for the test protocol executed (112). In
21 addition to PASS/FAIL results, performance tests may have other outcomes
22 indicative of component performance such as numerical values. It will also be
23 appreciated that PASS/FAIL results may comprise numerical values, as for
24 instance if a value below a certain numerical limit is assigned a FAIL result.

25 As discussed herein above, during a product lifetime it is likely that the
26 product will change. As these changes occur it is likely that performance
27 testing protocols will likewise change. It is an important advantage of the
28 method of the invention that the product tracking data history being built
29 includes a record of which test protocol was run; hence the test identity code is
30 recorded. It is likewise an important advantage of the method of the invention
31 that new protocols may be easily installed on the central repository 14. This

1 eliminates any uncertainty as to which test protocol is being run by the
2 contractor, and also eliminates burdens associated with installing and training
3 contractors such as Alpha operators to run the tests. Additionally, the preferred
4 embodiment of the invention further comprises storing previous test protocol
5 versions on the central repository 14 for future reference.

6 It is noted that although FIG. 2A indicates that the diagnostic tool will
7 transmit the test identity code (112), this information may likewise be
8 determined by the central computer device 12 within the scope of the present
9 invention. By way of example, the diagnostic tool 20 may be prompted to
10 transmit performance test results, with the central computer 12 then querying
11 the central repository 14 for the current test identity codes corresponding to the
12 test protocols being executed.

13 The product tracking data history is finally built (114), and is
14 summarized in FIG. 2B (116). Generally, a preferred product tracking data
15 history as summarized in FIG. 2B (116) is representative of the sample product
16 tracking data history of Table 1. The unique printer identity code AZ467 is
17 first associated with the tracking data history; in this manner there will be one
18 individual tracking history for each individual product. Product specification
19 data as well as performance test results are then placed in the file. As indicated
20 this data generally comprises an inventory of components installed, assembly
21 specifications used to install the components, dates installed, performance test
22 results for the components, identity of performance test protocols run, and
23 dates the performance tests were run.

24 The actual product tracking data history created is preferably in
25 computer readable format, and is placed in the data repository 14 of FIG. 1.
26 The product tracking data history has been indicated as file 26 in FIG. 1. In a
27 most preferred format the file is in a widely readable database or spreadsheet
28 format, with examples including but not limited to Microsoft Excel or Lotus 1-
29 2-3. This advantageously makes it widely available.

30 FIG. 2B also indicates that a second Product Defect History file may be
31 created if any performance test had a fail result (118). As an example, it is

1 noted from Table 1 that the printer 4 had a FAIL result for "Disk Drive Rev. 2"
2 performance test. This FAIL flag when processed (118) results in creation of a
3 product defect history file (120). If no FAIL results were obtained, no action is
4 taken (119). This product defect history file generally comprises a history of
5 tests run on the components and test results. The product defect history file
6 will be placed on the central repository 14, as indicated by file 30 in FIG. 1.

7 In practice, when a product is determined to have a defect, it may be
8 directed to a second contractor or group for defect resolution. In the
9 hypothetical printer manufacture process as presented by FIG. 1, upon
10 detection of the disk drive failure, the printer 4 is sent to defect resolution
11 contractor Beta 8 for repair. Once at Beta 8, the printer 4 is connected to the
12 Beta operator device 16, which in turn allows the printer 4 to communicate
13 with the central computer device 12 over the network 10. After transmitting
14 the printer 4 unique identity code AZ467 to the central computer device 12, the
15 Beta operator may obtain access to both the product defect history file 30 and
16 the product tracking data file 26 for output on the operator output monitor 18.

17 With this valuable information the Beta operator may attend to quickly
18 resolving the disk drive defect in the printer 4. The Beta operator is not
19 required to obtain paper histories of the printer 4 manufacture or testing from
20 Alpha 6 or Acme 2, or to have personal interface with Alpha 6 or Acme 2 as
21 was required for methods of the prior art. This greatly speeds and reduces the
22 cost of the defect resolution process.

23 Any changes made to the printer 4 by Beta 8 in resolving the defect may
24 further be recorded remotely over the communications network 10 in the
25 product data tracking history 26 and in the product defect history file 30.
26 Additionally, at the completion of defect resolution at Beta 8, performance
27 testing of the disk drive as well as additional components as may be required
28 using the performance test protocol set 24, with results also recorded in the
29 product tracking data history, as indicated in the sample product tracking data
30 history of Table 1.

1 It will be appreciated that many variations on the preferred embodiment
2 of the method of the invention as described herein are within the scope of the
3 claims appended hereto. As an example, additional contractors may be
4 comprised in addition to those illustrated in FIG. 1 and discussed herein. A
5 second assembly contractor, in addition to Alpha 6, for instance, could be used
6 to install an additional group of components on the printer 4.

7 Further, it will be appreciated that the method of the invention is not
8 limited to a contract manufacture situation, but likewise may be applied to
9 purely internal manufacture. In this sense it would be applicable to describe
10 the product owner Acme in FIG. 1 to comprise a design group, and contractor
11 Alpha to comprise an Acme manufacturing group that may be located in the
12 same location as the product owner group and that is connected to the product
13 owner group via a LAN. The assembly group could of course likewise be
14 remotely located.

15 It will further be appreciated that the group of method steps as described
16 in the flow chart of FIGS. 2A-2B should not be considered to limit the
17 sequence of steps described therein. It will be apparent that the steps described
18 could be carried out in a different sequence to accomplish the same result. For
19 example, nodes 108 and 110 could easily be reversed in sequence without
20 changing any method results. As an additional example, the printer 4 could be
21 connected to an operator computer device 16 at an earlier step in the flow chart
22 so that the printer 4 is "on-line" throughout assembly.

23 Additionally, it will be appreciated that the method of the invention as
24 claimed will be equally applicable to automated manufacturing that does not
25 require human operators. As an example, the operator computer device 16 at
26 Alpha 6 could comprise or control a robotic device that assembles the printer 4.
27 Further, sets of assembly specifications could comprise executable instruction
28 for the robotic devices.

29 It will further be appreciated that the method of the invention is well
30 suited to performance by a computer, and may in fact comprise the steps of the
31 invention as described herein in the form of a set of computer instructions

1 contained in a computer accessible medium such as a magnetic or optical
2 storage media for causing a computer to perform the various steps of the
3 method of the invention.

4 In particular, the present invention may comprise a computer program
5 product for causing the central computer 12 of FIG. 1 to create a product
6 tracking data history file for printer 4 by executing instructions that cause the
7 central computer 12 to interface with the diagnostic tool 20 and with operator
8 device 16 over the data network 10 to perform the various steps of the method
9 of the invention as described herein.

10 The various steps of the method of the invention as detailed herein with
11 reference to a preferred embodiment thereby provide a novel and efficient
12 method for building a comprehensive product tracking data history for a
13 product as it is manufactured by a plurality of contractors. As summarized in
14 the hypothetical product tracking history of Table 1, the history provides a
15 detailed history of what was installed in the product by whom, when it was
16 installed, and under what specifications. Additionally, a history of what
17 protocols were used to test each component, when it was conducted, and what
18 results were obtained is likewise recorded. Importantly, this comprehensive
19 product tracking data history is able to be built through the novel method of the
20 invention with much greater accuracy and with much less cost and effort than
21 was possible using methods of the prior art.

22 The advantages of the disclosed invention are thus attained in an
23 economical, practical, and facile manner. While preferred embodiments and
24 example configurations have been shown and described, it is to be understood
25 that various further modifications and additional configurations will be
26 apparent to those skilled in the art. It is intended that the specific embodiments
27 and configurations herein disclosed are illustrative of the preferred and best
28 modes for practicing the invention, and should not be interpreted as limitations
29 on the scope of the invention as defined by the appended claims.

30 Various features of the invention are set forth in the appended claims.